WASHINGTON STATE DEPARTMENT OF
Natural Resources
Peter Goldmark - Commissioner of Public Lands

Caring for
your natural resources
... now and forever

January 29, 2014

Board of County Commissioners
1300 Franklin St
PO Box 9810
Vancouver, WA 98666-9810

Dear Commissioners,

This letter represents the Washington State Department of Natural Resources' (DNR) perspective on the proposed elimination of the state trust lands adjacent to the Livingston quarry from the Clark County Surface Mining Overlay (SMO). It is of vital importance not only to the trust, but to Clark County itself that the SMO include these lands. DNR urges you to reject the Planning Commission's decision to *not* designate these lands as Mineral Resource Lands (MRL) for the following reasons:

- *Not* specifying the DNR-managed lands around the quarry as MRL may be in conflict with the State Growth Management Act (GMA),
- Including these trust lands in the SMO meets the mandatory elements in Clark County's Surface Mining Overlay project summary update,
- Multiple studies over the past two decades identify a high quality rock aggregate resource estimated to be as much as 11 million tons on state lands to the west and north of the present quarry,
- The state will receive a projected $5.5 million in royalty payments over the life of the current lease (next 13 years), $3.85 million of which is projected to go directly to the Clark County school system,
- Due to current and projected population growth in Clark County, demand is high for quality aggregate resources to support necessary infrastructure, and
- Mining in the Livingston quarry began in 1947 and residential development should not have occurred without mine awareness by prospective residents.

We must consider the societal value of the Livingston quarry area resource in the present and for the future. Road aggregate is what we drive on every day and it is one of the major ingredients in concrete. Having an excellent source close to a market is a way to keep infrastructure costs (and taxes) under control and, in this instance; it is a way to ensure funding for local schools for decades to come. The Livingston quarry contains proven exceptional quality aggregate. The state trust lands around it with high resource potential should be officially designated as MRL and be part of the Surface Mining Overlay for future generations.

For the reasons presented, DNR is requesting Clark County designate these recognized rock resource lands as MRL and for the SMO to include them. Please refer to Appendix A for additional supporting information for this request.

If you have any questions please contact, Venice Goetz, State Lands Minerals Geologist, LEG #468 at 360-902-1056 or venice.goetz@dnr.wa.gov.

Sincerely,

Kyle Blum
Deputy Supervisor for State Uplands

c: Darin Cramer, Product Sales & Leasing Division Manager
Thomas Shay, Leasing & Business Management Assistant Division Manager
Bob Johnson, State Lands Assistant Regional Manager
Valerie Uskoskie, State Lands Minerals Geologist
John Dentler, Attorney-at-Law

Appendix A

Legal and policy framework

The State Growth Management Act (GMA) and the minimum guidelines adopted by rule pursuant to the GMA strongly suggest that the DNR lands around the existing Livingston Mountain quarry must be designated as Mineral Resource Land (MRL)[1]. All data and evidence show these lands meet the GMA guidelines for naming and protecting MRLs and in view of the law and the facts, the failure to designate the proven DNR lands as MRL likely conflicts with the GMA.

The studies conducted on DNR lands adjacent to the Livingston quarry are also in alignment with the mandatory elements in Clark County's Surface Mining Overlay project summary update[2] which is based on WAC 365-190-070 Mineral resource lands. The second and third mandatory elements state that the county must identify and classify and then designate known mineral deposits of long-term commercial significance so that access to them is not knowingly precluded. Because the findings of studies have concluded that there is significant long-term commercial potential on State Trust lands adjacent to the Livingston quarry, logic requires that the county includes these lands in their SMO. Citing Table 3.4 Matrix for Assessing Mineral Resources in Clark County's Comprehensive Plan 2004, the deposit lies in the category of "highly desirable" due to the high quality of the rock, the size of the deposit (11M tons) (Figure 1) (Lasmanis, 2009, p.18), the immediate access of the rock to its market (less than 10 miles from Vancouver), and its compatibility to nearby areas. To the west and north of the quarry where proven reserves lie, compatibility is very good as there is no urban development on state lands. Thus, environmental issues such as noise, dust, vibrations, visual and the like should be non-existent or minimal. Mitigation to ease truck traffic, and visual impact should be a simple matter as the mine has been in existence since 1947 and complies with current traffic and safety requirements.

Natural resources of this quality and quantity are rare within close range of such a large urban market and should be made accessible to fulfill the growing needs of that market. Having a rock source close-in reduces the carbon footprint by minimizing transport and traffic, and thus lowers the ecological and economic cost of the material.

Mining can only occur wherever the resource exists and likewise, the resource in its found location cannot be moved to a more convenient location to be mined. The Livingston quarry was first mined in 1947 and then intermittently until the present. Rural residential development after establishment of the mine should not have occurred without mine awareness by prospective residents[3] [4]. The allowance of future residential development adjacent to a proven mineral resource may be in conflict with the mandatory elements of comprehensive plans in the State GMA[5]. Consideration must be given to the possibility of developing the deposit further as a major industrial land to fulfill the great need for crushed rock. This corresponds to RCW36.70A.365[6] pertaining to major industrial developments that are natural resource-based and makes them a priority if they are adjacent or in close proximity to the urban growth area.

Potential revenue

The extension of the SMO onto State Trust lands adjacent to the Livingston quarry is critical as it will provide revenue to support education and state services for many, many years. A lease renewal in 2027 coupled with the growing demand for crushed rock over time could earn the Trust an estimated

$9.8M due to verified reserves of over 11M tons of high grade rock. These reserves were proven during the drilling project (WA DOT, 2008, and Lasmanis, 2009). [Eleven (11) million tons at DNR's revenue rate of $1.25 per ton yields $13,750,000 and 75% of that to the Trust (Clark County schools) would be $10.3M. See Fig.1.] The expansion of the SMO to include the proven mineral resources on state lands around the Livingston quarry is of extreme importance in achieving this financial goal. Washington State prides itself on its outstanding educational system and monetary support of its schools is imperative in maintaining this status.

Previous studies

A rock aggregate inventory map produced by the Department of Natural Resources (DNR) Division of Geology and Earth Resources (Johnson et al, 2005) shows where minable aggregate occurs in Clark County. Well logs and geotechnical borings were used in this study to accurately delineate the occurrences of aggregate resources and further testing verifies its quality. The findings specify that the rock in the Livingston quarry and on adjacent state lands falls into the highest resource category: "identified". "Identified resources are gravel or bedrock aggregate for which distribution, grade, and quality can be confidently estimated from specific geologic evidence, limited sampling, and laboratory analysis" (Johnson et al, 2005).

The exceptional attributes and lateral and vertical extent of the Livingston quarry rock were also proven in areas to the north of the mine by a study (Lasmanis, 2009) that included drilling and testing. Five (5) holes were drilled on a prominent NE-SW-trending ridge which extends over a quarter-mile within state lands north and west of the present mine. This area is not adjacent to any dwellings. The average hole depth was 91 ft with quality rock throughout.

Calculating projected population growth based on census figures for the years 2010 to 2013, (USDC, 2012), and recent past demand based on the most recent USGS Mineral Industries Survey (2010), Clark County will need well over 2M tons of crushed rock in 2014. The number of tons needed per capita grows by about 1% a year while the population grows at 3% per year. These figures indicate a need for aggregate in the County that can be predicted to increase rapidly in the future. According to the census data the overall population in Washington expanded by 2.5% between 2010 and 2012, but Clark County gained 3% in population during that time, ostensibly in the greater Portland area. Therefore it is critical to take these numbers into account and approve the extension of the SMO into the State Trust lands adjacent to the Livingston quarry for future use.

Endnotes

[1] **RCW 36.70A.131 Mineral resource lands.**
Review of related designations and development regulations. As part of the review required by RCW 36.70A.130(1), a county or city shall review its mineral resource lands designations adopted pursuant to RCW 36.70A.170 and mineral resource lands development regulations adopted pursuant to RCW 36.70A.040 and 36.70A.060. In its review, the county or city shall take into consideration: (emphasis added)

(1) New information made available since the adoption or last review of its designations or development regulations, including data available from the department of natural resources relating to mineral resource deposits; and..." (emphasis added)

[2] The **mandatory elements of the Clark County Surface Mining Overlay** are derived from **WAC 365-190-070 - see below.**

- .....
- *The County must identify and classify mineral resource lands from which the extraction of minerals occurs or can be anticipated.*
- *The County must designate known mineral deposits so that access to mineral resources of long-term commercial significance is not knowingly precluded.*
- .....

WAC 365-190-070 Mineral resource lands.

(1) In designating mineral resource lands, counties and cities must approach the effort as a county-wide or regional process, with the exception of owner-initiated requests for designation. Counties and cities should not review mineral resource lands designations solely on a parcel-by-parcel basis.

(2) Counties and cities must identify and classify mineral resource lands from which the extraction of minerals occurs or can be anticipated. (emphasis added)

.....

(4) Designation of mineral resource lands.

(a) Counties and cities must designate known mineral deposits so that access to mineral resources of long-term commercial significance is not knowingly precluded. (emphasis added) *Priority land use for mineral extraction should be retained for all designated mineral resource lands.*

[3] **RCW 36.70A.060 Natural resource lands and critical areas — Development regulations**
(1)(a)...pursuant to RCW 36.70A.040. Such regulations shall assure that the use of lands adjacent to agricultural, forest or mineral resource lands shall not interfere with the continued use, in the accustomed manner and in accordance with best management practices, of these designated lands for the production of food, agricultural products, or timber, or for the extraction of minerals. (emphasis added)

(b) Counties and cities shall require that all plats, short plats, development permits, and building permits issued for development activities on, or within five hundred feet of lands designated as agricultural lands, forest lands, or mineral resource lands, contain a notice that the subject property is within or near designated agricultural lands, forest lands, or mineral resource lands on which a variety of commercial activities may occur that are not compatible with residential development for certain periods of limited duration. The notice for mineral resource lands shall also inform that an application might be made for mining-related activities, including mining, extraction, washing, crushing, stockpiling, blasting, transporting, and recycling of minerals. (emphasis added)

[4] **Clark County Mineral Focus Group Final Report, *1994*,** (emphasis added) **Comprehensive Plan General Policies, Tier 1 Policies:** #3 Establish standards and programs whereby residents of rural lands adjacent to designated resource lands are informed that they are locating in a natural resource area and that will be subject to normal and accepted mining practices that comply with federal, state, and local regulations (emphasis added)

[5] **RCW36.70A.070 Comprehensive plans - Mandatory elements.**
(4)(c)(v) Protecting against conflicts with the use of agricultural, forest, and mineral resource lands designated under RCW 36.70A.170.

[6] **RCW 36.70A.365 Major industrial developments.**
(1) "Major industrial development" means a master planned location for a specific manufacturing, industrial, or commercial business that: (a) Requires a parcel of land so large that no suitable parcels are available within an urban growth area; or (b) is a natural resource-based industry requiring a location near agricultural land, forest land, or mineral resource land upon which it is dependent. (emphasis added)

(2)(h) An inventory of developable land has been conducted and the county has determined and entered findings that land suitable to site the major industrial development is unavailable within the urban growth area. Priority shall be given to applications for sites that are adjacent to or in close proximity to the urban growth area. (emphasis added)

Figure 1 – Resource Calculations – tons and value (Lasmanis, 2009, p.18). "Measured" reserves of basaltic andesite = 9,741,177 tons plus "measured" reserves of breccia at 50% = 1,332,500 tons. Together they add up to 11M tons in reserves or $14M in revenue. The School Trust in Clark County would gain $9.8M.

RESOURCE CALCULATIONS – TONS AND VALUE

Based on preliminary field examinations, the Section 11 TLT block had an "Inferred" reserve of quality rock. The drilling of five holes and a testing program brought the inferred reserves up into the "Measured" category with a high level of confidence (see Appendix A for definitions).

The calculation is based on designing a multi-level rock quarry that would mine the upper and lower basaltic andesite for crushed stone products. The middle unit of tuff and breccia will have to be eventually mined to get at the lower andesite unit. It is estimated that at least 50% of the middle unit could be sold for rock fill and similar uses.

The DNR Upland Mapping Tool was used to calculate the area of "Measured" reserves. Property set backs of 30', as required by RCW 78.44, were utilized for the boundaries of the mineable upper unit on the north boundary. With the 2:1 slope of the pit walls, an 80' set back was necessary on the north and east to calculate the mineable area of the lower unit. The calculation is tabulated in the following figure:

Figure 11. Measured reserve calculations by geologic unit

Unit	Avg. thickness	Acres	Vol. c.y.	Avg. s.grav.	Tons per yd.	Tons
Upper andesite	45'	10	48,400	2.872	2.42	1,756,920
Middle breccia	40'	20	96,800	2.457	2.07	2,665,000
Lower andesite	70'	30	145,200	2.806	2.36	7,984,257

The totaled "Measured" reserves of basaltic andesite = 9,741,177 tons

"Measured" reserves of breccia at 50% = 1,332,500 tons

Using the latest data from the WSDOT study (Joint Transportation Committee, 2008), for valuation purposes, a 2008 average value of $13.56/ton is applied to the 9,741,177 tons of crushed stone andesite aggregate. This compares favorably with the 2007 negotiated agreement with Clark County Public Works for stone aggregate at $12.50/ton (royalty to DNR @ $1.25/ton). For the red volcanic breccia, and estimated $6.80/ton is used for this evaluation. The Section 11 Little Baldy deposit total values follow:

Value of crushed andesite stone aggregate= 9,741,177 x $13.56/t = $132,090,360

Value of breccia.....= 1,332,500 x $ 6.80/t = $ 9,061,000

TOTALS $141,151,360

Royalty to DNR at 10% would equal..... $ 14,115,136

References

Clark County 20-year Comprehensive Growth Management Plan (2004-2024) p. 3-12: Table 3.4 Matrix for Assessing Mineral Resources

Clark County Rural and Natural Resource LANDS Advisory Committee Mineral Focus Group Final Report (1994)

Clark County Surface Mining Overlay project summary update

Johnson, Chris N., Palmer, S.P., and Poelstra, J.L., 2005, Rock aggregate resource lands inventory map for Clark County, Washington, Washington Division of Geology and Earth Resources, resource map 1.

Lasmanis, R., 2009, Evaluation of stone aggregate resources, Section 11 – property Camp Bonneville, Clark County, Washington, 20p plus maps, figures, and diagrams of borings logs and notations, and DOT test results.

RCW 36.70A.040 (1990)
RCW 36.70A.060 (1990)
RCW 36.70A.070 (1995)
RCW 36.70A.130 (1995)
RCW 36.70A.131 (1998)
RCW 36.70A.160 (1990)
RCW 36.70A.170 (1990)
RCW 36.70A.365 (1995)

United States Department of Commerce, United States Census Bureau, 2013 for Clark County, Washington, online at http://quickfacts.census.gov/qfd/states/53/53011.html

United States Geological Survey 2011 Minerals Yearbook – Stone, crushed [Advance release], 2010, 24p.

EVALUATION
OF STONE AGGREGATE RESOURCES

SECTION 11 - PROPERTY
CAMP BONNEVILLE, CLARK COUNTY, WASHINGTON

by

Raymond Lasmanis
Licensed Geologist
Land Management Division
Washington Department of Natural Resources

January 22, 2009

EXECUTIVE SUMMARY

The Camp Bonneville Department of Natural Resources (DNR) property of interest in Section 11 consists of 80 acres centered on Little Baldy. Drilling and testing program demonstrated that the property contains proven reserves of high quality crushed rock aggregate totaling 9.7 million tons and an additional 1.3 million tons of rock suitable for other purposes. Based on prices from an adjacent county lease and current Washington State Department of Transportation crushed surfacing rock costs, the deposit has a total value of $141,151,000. Using a 10% royalty rate, the revenue to DNR would total $14,115,000 over 18.5 years.

It is recommended that DNR remove 80 acres (NW ¼ of NE ¼ and NE ¼ of NW1/4 of Section 11, T.2N., R.3E.) from the Trust Land Transfer list.

The NW ¼ of the NW ¼ of Section 11 (40 acres) contains no rock or sand/gravel resources and can be transferred to Clark County via Trust Land Transfer.

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Appendix A – Resource Classification Standards

Appendix B – WSDOT field engineer drill logs

Appendix C – Geological drill logs with sample intervals & test results

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Appendix E – Section 4, Payment, page 3 of Agreement 32-079404
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INTRODUCTION

The Camp Bonneville Military Reservation is located in the southeast part of Clark County and has been operated as a training facility by the U.S. Army. The military lands have been transferred to Clark County for open space, recreation, forestry, and fish and wildlife habitat. Since 1955, two state parcels have been leased by the Department of Natural Resources (DNR) to the U.S. Army as part of this military reservation. These two parcels, in Sections 36 and 11 (see Figure 1), have been proposed to be turned over to Clark County through the Trust Land Transfer Program (TLT).

A rock and sand/gravel evaluation of TLT parcels was requested from Raymond Lasmanis. On November 7, 2007 a field examination was conducted of Section 36 and 11. As ordinance disposal work was under way and large areas have not been screened, the field examination was conducted under escort by Range Control staff. There are no sand/gravel deposits on the property and Section 36 did not have any commercial rock potential. Subsequently, the 640 acres of Section 36 were approved for a TLT to Clark County on July 1, 2008. In a preliminary report, Lasmanis indicated that Section 11 had commercial rock potential and should be with held from TLT. In a subsequent report, dated March 28, 2008, Lasmanis indicated that at a minimum 80 acres in Section 11 contained an "Inferred" reserve of 2.8 million tons of commercial rock with a royalty value of $1.25/ton and recommended diamond drilling to develop a "Measured" reserve of quality rock (see Appendix A for definitions).

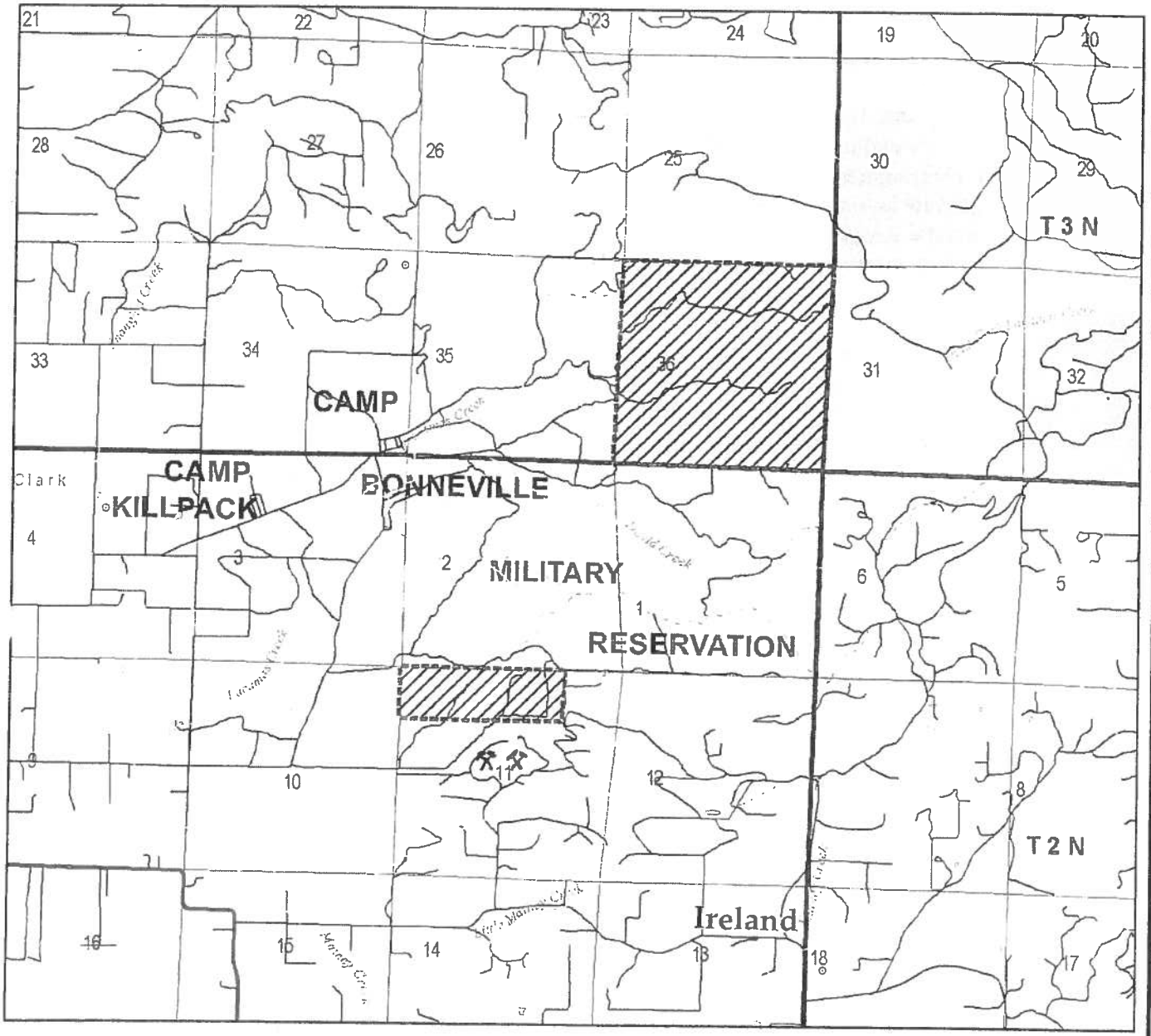
This report presents the results of the 2008 drilling program including rock quality testing, geology of the favorable rock units, and "Measured" reserve calculations. For location of drill holes and topography, see Figure 2.

PROPERTY LOCATION AND SITE CONDITIONS

The DNR property consists of 120 acres described as NW1/4 of NW1/4, NE1/4 of NW1/4, and NW1/4 of NE1/4, Section 11, T.2N., R3E., Clark County. The NW1/4 of NW1/4 (40 acres) has no potential and is not part of this evaluation. The remaining 80 acres cover a topographic high, called Little Baldy, with elevations ranging from 1000' above sea level to the summit at 1,457' above sea level.

Figure 1. LOCATION MAP

Department of Natural Resources
2007-2009 Trust Land Transfer Project
Camp Bonneville



DNR lands are situated to the south of NE1/4 of NW1/4; private lands to the south and east; and former military lands (now Clark County) to the north (see Figure 1). The DNR lands to the south contain commercial rock in the Livingston Pit and are now leased to Clark County Public Works, Agreement No. 32-079404. The 40 acres in SW1/4 of NE1/4 are owned by Alan Thayer and have been leased to Tower Rock Products (Tapani Underground) for the Livingston Mountain Quarry. Mining began there in the latter part of 2008.

The slopes of the DNR property are covered by mature timber. On the 80 acres in question, there are no streams or wetlands. Due to the nature of the very hard capping rock and the Yacolt Burn, the top of Little Baldy and its SW flank are bare with only moss and grasses partially covering rock outcrops.

The property was part of the military reservation. Range Control had to clear the access road and drill sites before drilling could begin. Rifle shell casings and machine gun casings were found at the drill locations. To date, the remaining 80 acres have not been cleared for access as the ordinance disposal teams are concentrating on Sections 3 and 10.

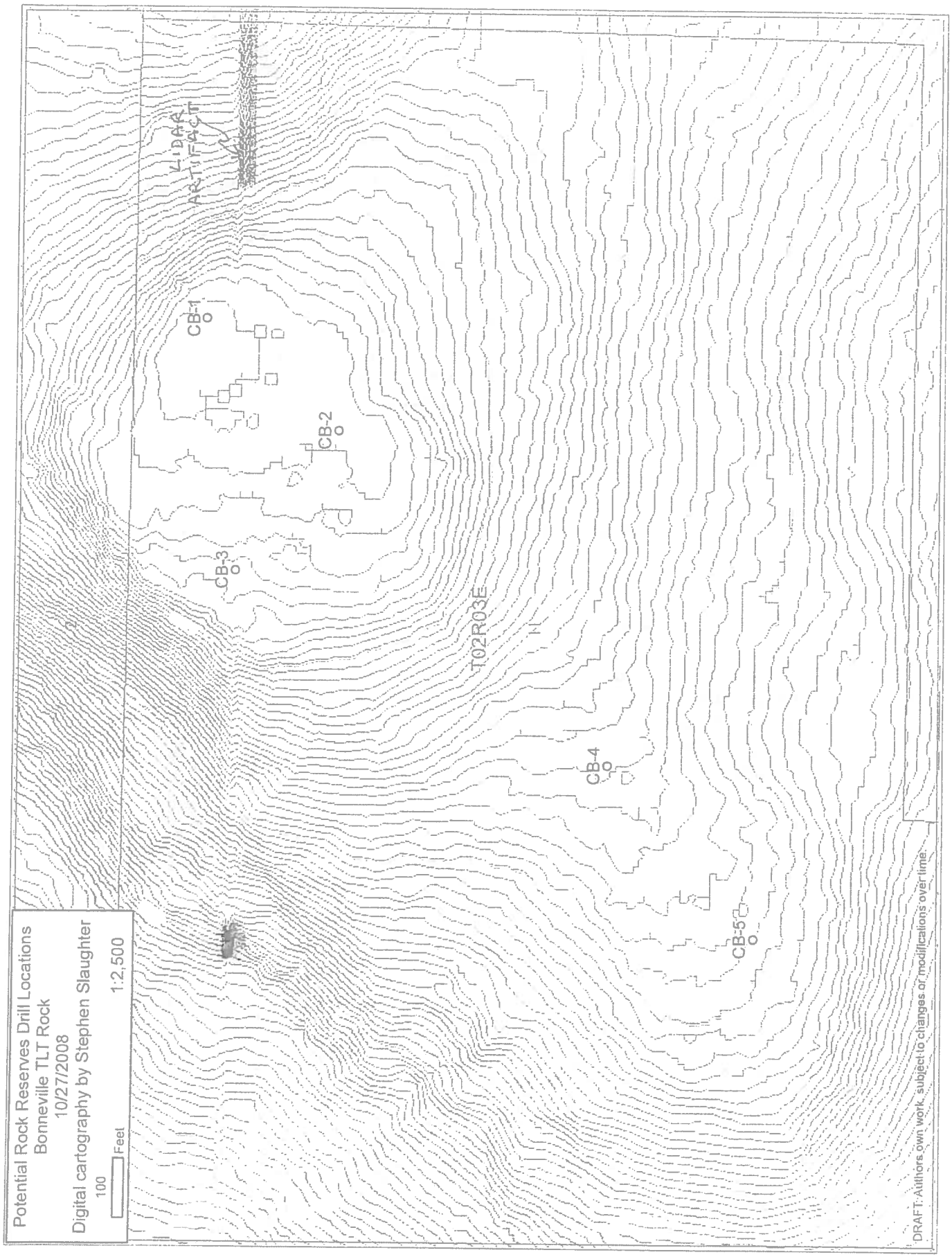
GROWTH MANAGEMENT MINERAL RESOURCE LANDS

Surface mine permitting in Clark County is governed by Title 40 of the Unified Development Code. The code, to ensure the continued use of rock, stone, gravel, sand, and minerals, has adopted by reference Chapter 78.44 RCW and Chapter 332-18 WAC. Clark County's Chapter 3, Mineral Lands, implements the Growth Management Act (RCW 36.70A.040(3)(b)) by designating mineral resource lands with a Surface Mining Overlay District.

Since 1994, a Surface Mining Overlay District has been created for lands adjacent to the 80 DNR acres covering Little Baldy in Section 11. They are for the Livingston Pit (40 acres- SE1/4 of NW1/4) and the Livingston Mountain Quarry (40 acres- SW1/4 of NW1/4).

Since the proposed TLT lands in Section 11 were part of Camp Bonneville Military Reservation, they have not been zoned for mineral extraction. With Growth Management Act guidelines, the Clark County Comprehensive Plan 2004-2024, Chapter 3, does provide for a process to designate mineral resource lands of long-term commercial significance. An application for such a designation would be evaluated by Clark County against a decision matrix (Table 3.4, page 11, Chapter 3).

Figure 2. TOPOGRAPHY



The Section 11 rock deposit in this study documented 10 million tons of high quality rock. Plotting the attributes and potential impacts of the deposit on the Clark County decision matrix, places it in the "Protection Highly Desirable" category to ensure future supply of crushed stone aggregate. This provides for a high level of confidence that the deposit can be placed in a Surface Mining Overlay District like the two adjacent operations to the south.

GEOLOGY

Geological regional mapping by Phillips (1987) and others shows that the property is covered by Skamania Volcanics of Upper Oligocene age dated at 28 million years. In the camp Bonneville area, volcanic unit Tva_2 has been described as consisting of thick, platy-jointed basaltic andesite flows inter-bedded with basalt and tuff beds. Three regional samples of the volcanic unit Tva_2 gave an average chemical composition of 54% SiO_2 corresponding well to basaltic andesite.

The site geology of Section 11 matches the description of unit TVa_2. Based on surface examination and confirmed by drilling, the geology of Little Baldy consists of a layer-cake of volcanic beds that are nearly horizontal (only a -2 deg. dip to the north). Little Baldy is capped by a bed of hard, dark basaltic andesite with an average thickness of 45'. This is underlain by reddish beds of tuff, fragmental tuff, and basalt volcanic breccia averaging, in total, 40' in thickness. On the southwest flank there are exposures of a second bed of hard, dark basaltic andesite averaging 70' in thickness. As demonstrated by drilling, this second bed extends under Little Baldy and contains a majority of the commercial rock reserves (see geologic map, Figure 3 and a geologic cross section, Figure 4). It is underlain by basalt volcanic breccia. See Appendix B for WSDOT engineer field logs and Appendix C for geologic logs of drill holes CB 1 through 5.

A similar volcanic sequence is present to the south in the two rock quarries. In the Livingston Pit (SE1/4 of NW1/4) highly jointed dark basaltic andesite is exposed in mine walls. The floor of the adjacent Livingston Mountain Quarry has a higher elevation and thus is mining in an overlying bed of reddish volcanic breccia.

GROUND WATER

The capping basaltic andesite bed comprising Little Baldy does not contain any significant ground water in the fractures. There are no springs at the break in the slope around Little Baldy. The tuff and fragmental tuff beds are clay rich and may be aquatards causing fractures in the lower basaltic andesite bed to hold water near the contact. The connectivity of these fractures and the presence of ground water in the lower basaltic andesite bed are not known. There is no ground water seeping from the mine faces of the Livingston and Livingston Mountain quarries.

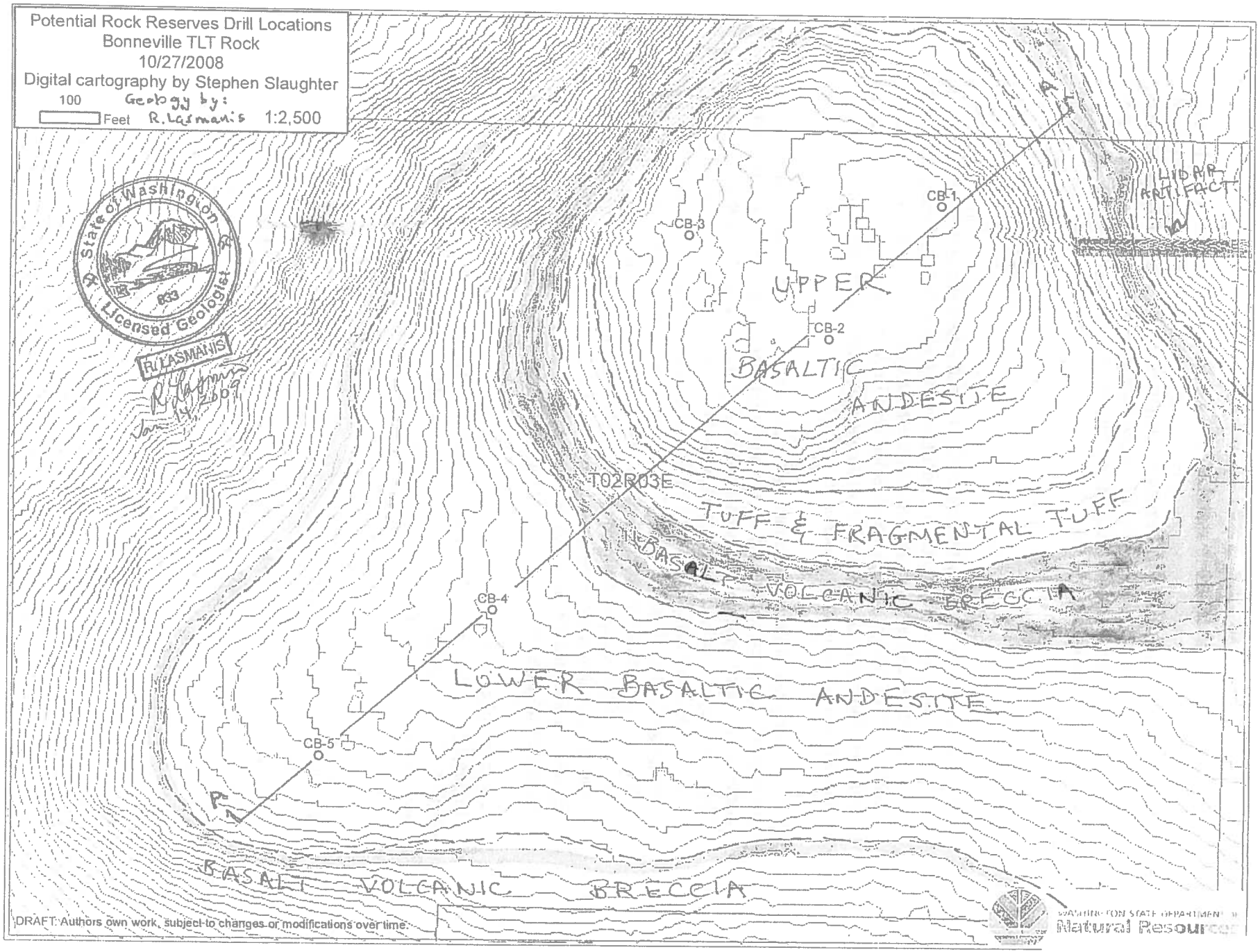
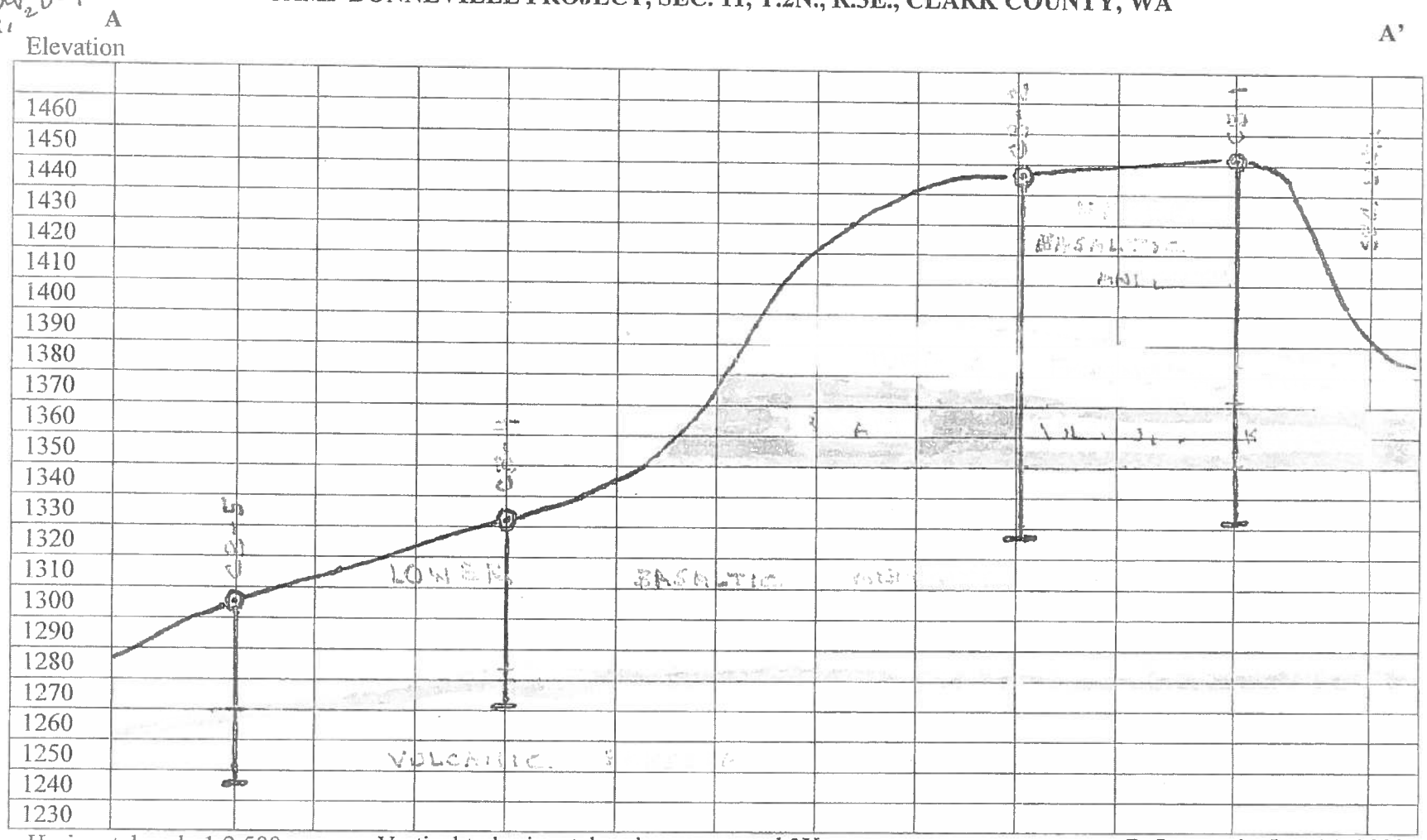


Figure 3. GEOLOGY

R. Lasmanis
Jan. 14, 2009

SOUTHWEST- NORTHEAST GEOLOGIC CROSS SECTION A – A'
CAMP BONNEVILLE PROJECT, SEC. 11, T.2N., R.3E., CLARK COUNTY, WA



Horizontal scale 1:2,500 Vertical to horizontal scale exaggerated 3X R. Lasmanis Jan. 14, 2009

Figure 4. GEOLOGIC CROSS SECTION

EVALUATION METHODOLOGY

Drilling and sampling

The potential of the 80 acres on Little Baldy in Section 11 can be inferred with some confidence based on the hardness of the basaltic andesite exposed at the summit and on the southwest flank. The three dimensional aspect (thickness and continuity) of the basaltic andesite and how the rock would test as to quality was needed to increase the level of confidence from a qualitative to a quantitative evaluation. The objective was to prove "Measured" reserves that meet or exceed Washington State Department of Transportation (WSDOT) specifications for crushed stone aggregate.

A drilling program of five holes was designed to test the thickness of the upper basaltic andesite bed, the thickness of the lower basaltic andesite bed, and, whether it extends under Little Baldy. Drilling was to be carried out by a diamond drill recovering continuous drill core 2 ½" in diameter (HQ core size). Drill hole locations are shown of Figures 2 and 3. Drill hole collar (elevation at ground level) elevations and locations was determined using a Garmin 60CSx instrument (Figure 5).

Figure 5 – Camp Bonneville Section 11 drill locations and elevation

Drill hole #	Latitude	Longitude	Y_proj.	X_proj.	elevation
CB-1	45.67937	-122.401	132041.4	1154658	1,451
CB-2	45.67874	-122.401	131816.1	1154469	1,447
CB-3	45.6792	-122.402	131988.3	1154231	1,429
CB-4	45.67744	-122.403	131357.4	1153904	1,331
CB-5	45.67674	-122.405	131109	1153613	1,305

The drilling and testing program was approved with funding coming from Program 993. To take advantage of cost savings and drill availability, an Interagency Agreement was signed on July 31, 2008 between WSDOT and DNR (Agreement No. IAA 09-41). Drilling commenced, after clearance from Range Control, on September 23, 2008 and completed on October 1, 2008. Five holes were drilled with a total footage of 457'. Core recovery was nearly 100% for tested rock sections. The total cost of the drilling and laboratory testing program was $52,357.61. See Figures 6 and 7 of the WSDOT drill, on site, at Camp Bonneville.

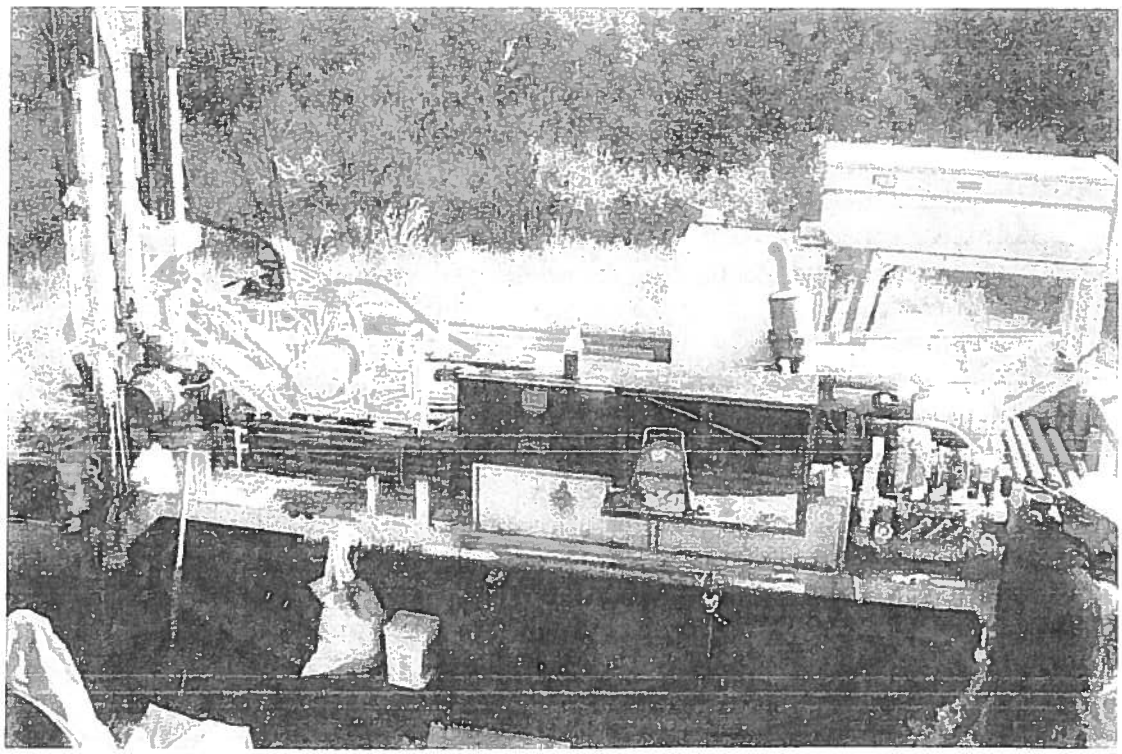


Figure 6. WSDOT DIAMOND DRILL

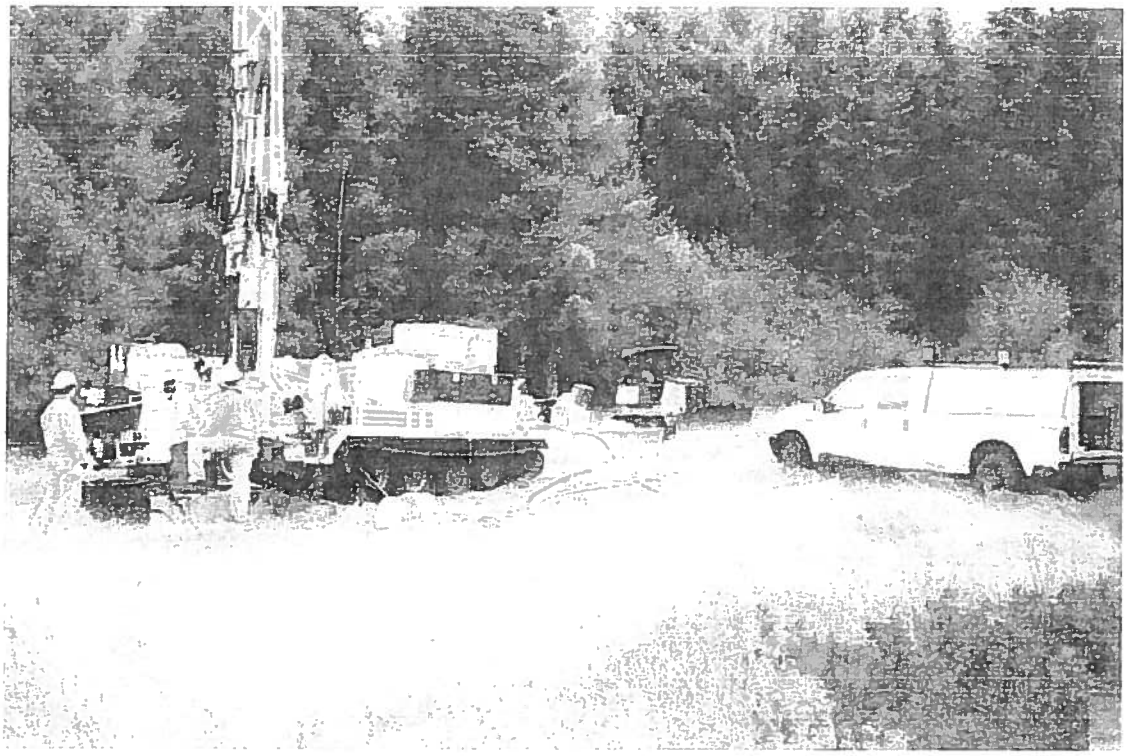


Figure 7. WSDOT DIAMOND DRILL on HOLE CB-4

Laboratory testing

The drill core was logged by geologic units. The test sample intervals were selected for each geologic unit in order to determine the rock quality of the basaltic andesite and the basaltic volcanic breccia. The tuff, commonly altered to clay, and the fragmental tuff was not tested as they obviously did not meet specifications. The nature of drill core from hole CB-3 can be seen in Figure 8. For each test interval, the sample was assembled by placing alternate one-foot entire core sections in a canvas bag to total approximately 80 lbs per test sample.

All samples were then submitted to WSDOT Materials Laboratory in Tumwater. It is this laboratory which measures the quality of the material according to state and national standards. These standards are established by American Association of State Highway and Transportation Officials (AASHTO).

In order to calculate the value of crushed stone aggregate, the following tests were performed and results posted on the geologic logs (Appendix C):

AASHTO T-85 -Bulk Specific Gravity (SSD) for tonnage conversion
AASHTO T-96 -LA Abrasion test to determine wear resistance (Fig. 9)
WSDOT TM-113 -Degradation Factor, wear in presence of water

SSD is the ratio of the weight in air of a unit volume of aggregate, including the weight of water within the voids filled to the extent achieved by submerging in water for approximately 15 hours, to the weight in air of an equal volume of gas-free distilled water at room temperature. See Appendix D for individual laboratory test result reports.

WSDOT has published minimum LA Abrasion and Degradation Factor requirements for various aggregate products (see Figure 14). The Camp Bonneville test results on drill core can be compared to these standards.

Figure 10. WSDOT Standard Specifications for various products

Aggregate product	L.A. wear test	Degradation Factor
Portland Cement Concrete (PCC)	<35	
Bituminous Surface Treatment (BST)	<35	>30
Asphalt Treated Base (ATB)	<30	>15
Hot Mix Asphalt- wearing course	<30	>30
Hot Mix Asphalt- other courses	<30	>20
Ballast	<40	>15
Crushed Surfacing- top course	<35	>25
Crushed Surfacing – base course	<35	>15

Ref: WSDOT 2006

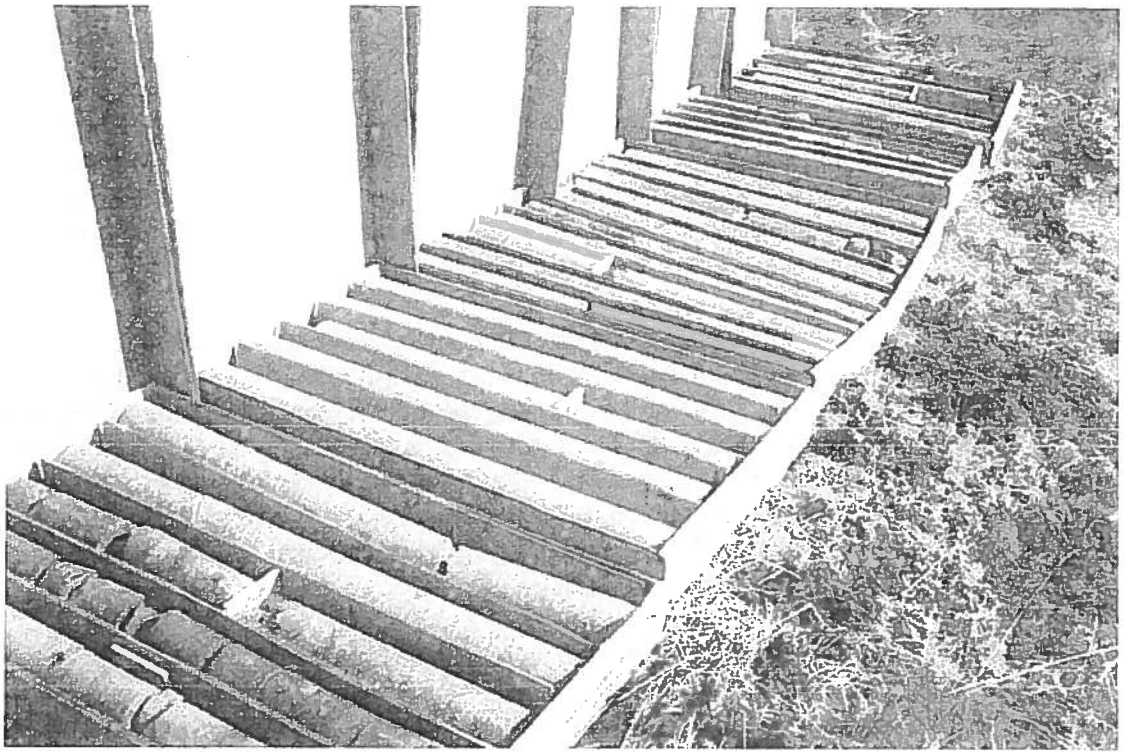


Figure 8.
Drill core from Hole CB-3: from left to right, green basaltic andesite, red clay and tuff, reddish & green basaltic breccia to last core box

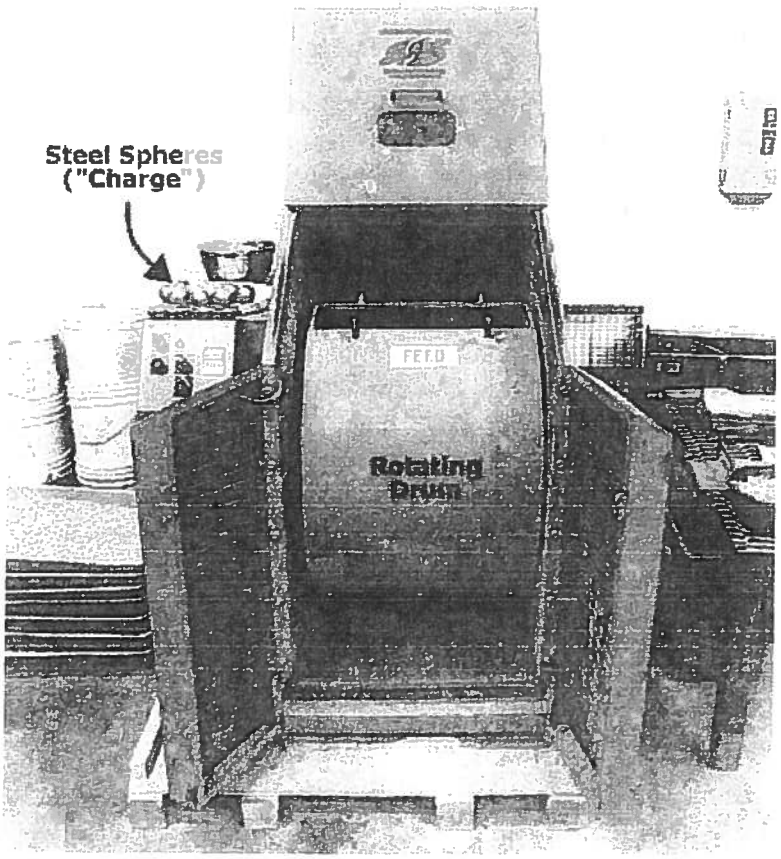


Figure 9.
L.A. Abrasion test Equipment

TESTING RESULTS

For L.A. Abrasion wear tests, the lower the value the higher the quality of crushed stone aggregate. Except for ballast, the resistance to abrasion has to be less than 35 for some applications and less than 30 for others. Degradation Factor results have to exceed from 15 to 30 depending on the product to be made from the crushed rock aggregate. Higher Degradation Factor results represent the best materials (Figure 10).

Five samples were submitted for testing from the upper basaltic andesite unit. Results show the rock to be of high quality suitable for all applications. The weighed average result for the L.A. test was 15.5 and the Degradation Factor of 55.4. In one of the sample intervals included in the average was a core section containing zeolites, chlorite, and oxidized rock giving a poor Degradation Factor of 13. However, this material would stand out in a mine face and could be easily bypassed and thus upgrading your product. The upgraded product would be of very high quality with weighed average results of 14.5 for the L.A. test and a Degradation Factor of 73.4.

A 40' thick unit of basaltic volcanic breccia topped by fragmental tuff, tuff, and clay separated the upper basaltic andesite unit from the lower one. The tuff and fragmental tuff sections were not tested as they are not suitable for aggregate. The red basaltic volcanic breccia, about 20' thick, is fairly competent but mineralized with zeolites and calcite. Tests confirm that the breccia is not suitable for aggregate even though the L.A. test gave an average 26.1 but with a poor Degradation Factor of 4.5. Rock fill would be the only market for this material and is currently being sold out of the Livingston Mountain Quarry to the south.

Five samples were submitted for testing from the lower basaltic andesite unit. Similar to the upper unit, the results also show the rock to be of high quality suitable for all applications. The weighed average result for the L.A. test was 16.8 and the Degradation Factor of 52.2. The average contained one sample which was partially oxidized to a red color and mineralized with calcite and zeolites with a Degradation Factor of 9. With selective mining, that portion could be bypassed resulting with a very high quality aggregate having an average L.A. test of 15.1 and a Degradation Factor value of 64.3.

Bulk specific gravity tests were performed on all samples. There is a general correlation between specific gravity and quality of the rock. Higher specific gravity values correspond with the basaltic andesite units. Simple averages for the units are: upper basaltic andesite at 2.872; middle unit of basaltic breccia at 2.457; and, lower basaltic andesite unit at 2.806. Another words, better quality rock has a higher density and weighs more per cubic yard than poor rock.

CRUSHED STONE AGGREGATE PRICE AND MARKET EVALUATION

The camp Bonneville Section 11 crushed stone aggregate deposit is located within the greater Portland – Vancouver market area. This region is experiencing unprecedented growth depleting existing rock and sand/gravel resources. Round rock aggregate and crushed rock is now being barged as far as 60 miles down the Columbia River or by rail to the Portland market. Operations in Cowlitz County are trucking rock to the Vancouver urban growth area. The Province of British Columbia has conducted a study on the feasibility of shipping aggregate to Portland by barge or ship but shallow draft limitations are a detriment (G.E. Bridges & Associates, 2004).

The latest data published for Washington state by the U.S.G.S. is for the year 2006. They show that 15,763,000 short tons of crushed stone was sold or used by producers in the state at an average value of $10.12 per short ton (Willett, 2007). This price is free on board (f.o.b.) plant and based on first point of sale or captive use. The value does not include transportation from plant or yard to consumer. It does, however, include all costs of mining, processing, in-plant transportation, overhead costs, and profit.

With declining sources for aggregate, Clark County Public Works recognized the need to acquire their own source of crushed rock for chip seal paving and other construction projects. On October 31st, 2007 Clark County Public Works signed Agreement No. 32-079404 with DNR for the Livingston Pit located in Section 11, T.2N., R.3E. The Agreement calls for a minimum annual royalty of $50,000 and a royalty rate of $1.25/ton for basaltic andesite (Appendix E). Using an internal guideline of 10%, this royalty equates to crushed rock value of $12.50/ton. There is a provision for a price adjustment every five years.

WSDOT tracks the costs of raw materials for all highway and bridge projects. As part of that study (Joint Transportation Committee, 2008) the cost to WSDOT of crushed aggregate for the period 1990 to 2008 has been assembled. A plot of that data (Appendix F) shows a 33% increase for crushed surfacing from $10.26/ton in 2003 to $13.56/ton in 2008.

RESOURCE CALCULATIONS – TONS AND VALUE

Based on preliminary field examinations, the Section 11 TLT block had an "Inferred" reserve of quality rock. The drilling of five holes and a testing program brought the inferred reserves up into the "Measured" category with a high level of confidence (see Appendix A for definitions).

The calculation is based on designing a multi-level rock quarry that would mine the upper and lower basaltic andesite for crushed stone products. The middle unit of tuff and breccia will have to be eventually mined to get at the lower andesite unit. It is estimated that at least 50% of the middle unit could be sold for rock fill and similar uses.

The DNR Upland Mapping Tool was used to calculate the area of "Measured" reserves. Property set backs of 30', as required by RCW 78.44, were utilized for the boundaries of the mineable upper unit on the north boundary. With the 2:1 slope of the pit walls, an 80' set back was necessary on the north and east to calculate the mineable area of the lower unit. The calculation is tabulated in the following figure:

Figure 11. Measured reserve calculations by geologic unit

Unit	Avg. thickness	Acres	Vol. c.y.	Avg. s.grav.	Tons per yd.	Tons
Upper andesite	45'	10	48,400	2.872	2.42	1,756,920
Middle breccia	40'	20	96,800	2.457	2.07	2,665,000
Lower andesite	70'	30	145,200	2.806	2.36	7,984,257

The totaled "Measured" reserves of basaltic andesite = 9,741,177 tons

"Measured" reserves of breccia at 50% = 1,332,500 tons

Using the latest data from the WSDOT study (Joint Transportation Committee, 2008), for valuation purposes, a 2008 average value of $13.56/ton is applied to the 9,741,177 tons of crushed stone andesite aggregate. This compares favorably with the 2007 negotiated agreement with Clark County Public Works for stone aggregate at $12.50/ton (royalty to DNR @ $1.25/ton). For the red volcanic breccia, and estimated $6.80/ton is used for this evaluation. The Section 11 Little Baldy deposit total values follow:

Value of crushed andesite stone aggregate= 9,741,177 x $13.56/t = $132,090,360

Value of breccia.....= 1,332,500 x $ 6.80/t = $ 9,061,000

TOTALS $141,151,360

Royalty to DNR at 10% would equal..... $ 14,115,136

CONCLUSIONS AND RECOMMENDATIONS

The Little Baldy rock deposit in Section 11 contains drill proven commercial quality crushed stone aggregate of 9,741,177 tons and an additional 1,332,500 tons of lower grade material. Using WSDOT average 2008 prices, the deposit contains $141,151,360 worth of rock. With a 10% royalty to DNR, the revenue would equal $14,115,136. These are current market values which would increase with time, in five year increments, as provided for in DNR leases.

The life of the operation, at 600,000 tons/year, is calculated at 18.5 years. It is estimated that it would take 6 months to get the Surface Mining Overlay District zoning designation from Clark County. The Environmental Impact Statement and permitting process may take 3 ½ years before production could begin.

It is recommended that DNR remove 80 acres (NW ¼ of NE ¼ and NE ¼ of NW ¼, Section 11, T.2N., R.3E.) from the Trust Land Transfer list at this time as the 80 acres contains a high value crushed stone aggregate deposit. There have been requests by industry to during the last two years to lease the Little Baldy deposit.

The NW ¼ of the NW ¼ of Section 11 (40 acres) can remain on the TLT list as it does not contain any rock or sand/gravel deposits of commercial potential.

Submitted by: Raymond Lasmanis
Licensed Geologist

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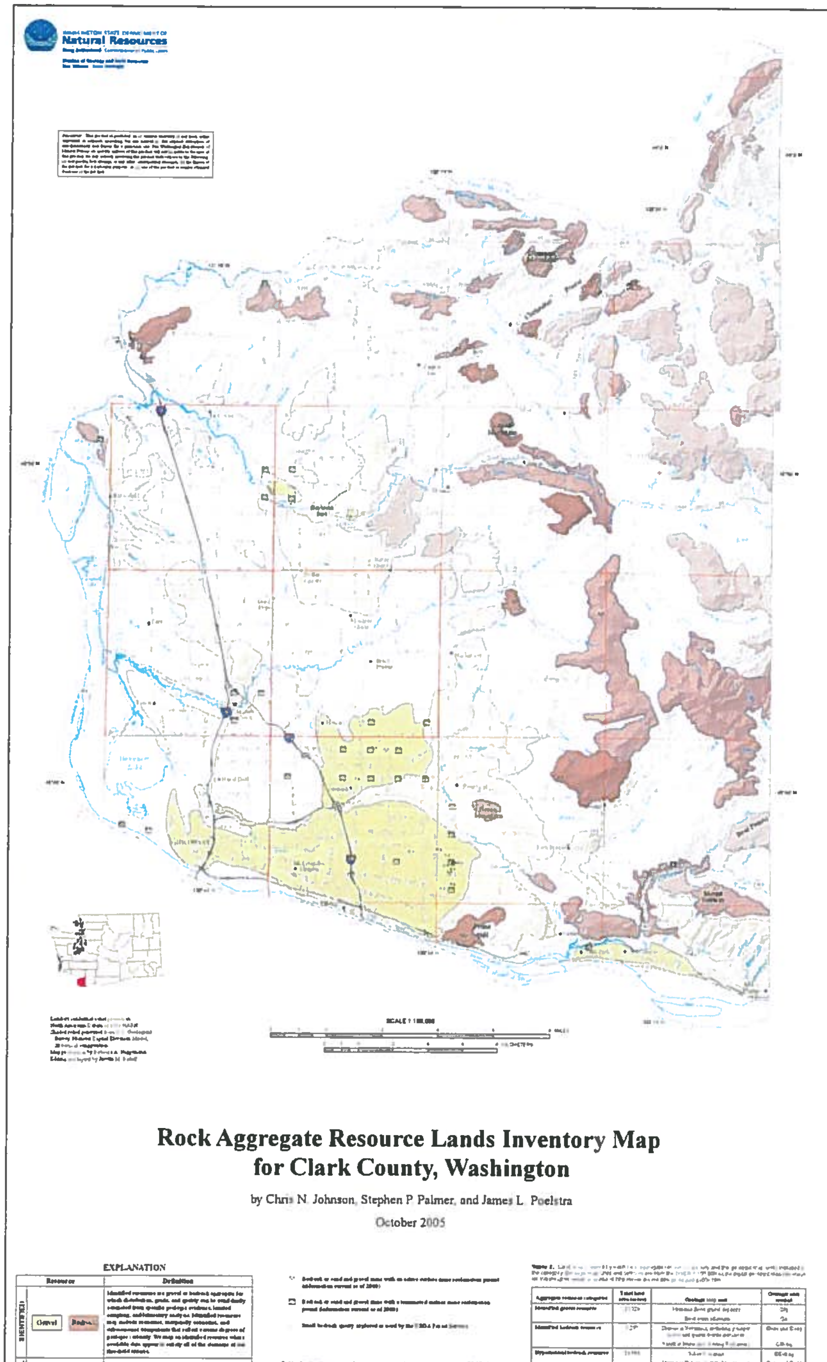

Rock Aggregate Resource Lands Inventory Map for Clark County, Washington

by Chris N. Johnson, Stephen P. Palmer, and James L. Poelstra

October 2005

EXPLANATION

Resource		Definition
IDENTIFIED	Gravel / Bedrock	[illegible]
HYPOTHETICAL	Bedrock	[illegible]
SPECULATIVE	Gravel / Bedrock	[illegible]

INTRODUCTION

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ACKNOWLEDGMENTS

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